

Description

METHANE FERMENTATION PRETREATMENT APPARATUS

Technical Field

5 [0001]

The present invention relates to a methane fermentation pretreatment apparatus used for pretreatment before a methane fermentation treatment is performed on organic waste, such as garbage and fish processing waste.

Priority is claimed on Japanese Patent Application No. 2010-261713, filed
10 November 24, 2010, the content of which is incorporated herein by reference.

Background Art

[0002]

In the related art, when a methane fermentation treatment is performed on
15 organic waste (biomass feedstock), such as garbage and fish processing waste, the treatment of solubilizing the organic waste (slurry preparation) so as to easily ferment is performed in order to improve methane fermentation efficiency.

[0003]

Additionally, a pretreatment step of the related art uses a methane fermentation
20 pretreatment apparatus, and the methane fermentation pretreatment apparatus includes, for example, a coarse crusher, a fine crusher, a sorter, a solubilization tank, and a screen (first solid-liquid separator) (for example, refer to PTL 1).

[0004]

Also, in the pretreatment step of the related art, the organic waste is cut in the
25 coarse crusher and the fine crusher in sequence. Thereafter, large-sized unsuitable

waste for fermentation (part of the unsuitable waste for fermentation) is coarsely sorted and removed from the organic waste by a sorter of a rotary type, a sifter type, or the like, and the organic waste after the treatment is fed to the solubilization tank. Next, the organic waste is subjected to a solubilization treatment while being heated in the solubilization tank, a solubilized liquid in a slurry state is made to pass through a screen, and the unsuitable waste for fermentation contained in the solubilized liquid is trapped and removed by this screen. Then, the solubilized liquid treated by the methane fermentation pretreatment apparatus in this way is supplied to a methane fermentation tank, and undergoes a methane fermentation step to produce methane gas.

Citation List

Patent Literature

[0005]

[PTL 1] Japanese Patent Publication No. 3710938

SUMMARY OF INVENTION

Technical Problem

[0006]

Among organic waste that comes from the garbage, unsuitable waste for fermentation, such as vinyl, plastics, cloth (fibers), disposable chopsticks, shells, bones, seeds, sand, and the like, becomes mixed with the organic waste. In the pretreatment, while such unsuitable waste for fermentation is removed, the organic waste is solubilized to generate a solubilized liquid (fermentation feedstock). In the above methane fermentation pretreatment apparatus of the related art, unsuitable waste for fermentation is removed by rough sorting by the sorter, and the unsuitable waste for fermentation is

precipitated or floated, separated, and removed in the solubilization tank. Moreover, the unsuitable waste for fermentation is trapped and removed from the solubilized liquid by passing the solubilized liquid through the screen provided between the solubilization tank and the methane fermentation tank.

5 [0007]

However, in this methane fermentation pretreatment apparatus, if the unsuitable waste for fermentation is removed with high efficiency by the sorter, the solubilization tank, or the screen, a large amount of solubilized liquid (fermentation feedstock) is lost together with the unsuitable waste for fermentation, and the recovery amount of the
10 solubilized liquid decreases considerably. Additionally, in the related art, a screen with a large mesh size of several millimeters to several tens of millimeters (for example, about 6 mm to about 10 mm) is used. Therefore, small-sized unsuitable waste for fermentation, such as sand, shells, eggshells, bone fragments, and the like, of which most of the part is made fine after a solubilization treatment passes through the screen.

15 [0008]

As the unsuitable waste for fermentation flows from the solubilization tank to the methane fermentation tank without being discharged out of a system as described above, in the methane fermentation tank and the subsequent steps (water treatment or the like), there is a case where mechanical problems, such as deposition of the unsuitable
20 waste for fermentation, and clogging and wear caused by the unsuitable waste for fermentation, occur in the tank or in devices, such as piping, an agitator, and a pump. Additionally, if the unsuitable waste for fermentation is not discharged out of the system, and the unsuitable waste for fermentation is accumulated in large amounts within the system, the performance of methane fermentation deteriorates.

25 [0009]

Moreover, the frequency of shutdown operation increases in order to perform periodic cleaning of the solubilization tank, remove unsuitable waste for fermentation from the methane fermentation tank, or the like. Additionally, there is a case where the unsuitable waste for fermentation within the system cannot be completely removed even
5 if such operation is performed. Particularly, since shells, eggshells, or the like contain calcium, which tends to accumulate as scale in the system and is not easily removed from the inside of the system, these become hindrances to operation.

Solution to Problem

10 [0010]

(1) A methane fermentation pretreatment apparatus used for pretreatment before a methane fermentation treatment is performed on organic waste, the apparatus including a solubilization tank in which a solubilization treatment is performed on the organic waste; a screen that is a first solid-liquid separator through which a solubilized liquid
15 obtained by performing a solubilization treatment in the solubilization tank on the organic waste is passed to remove a first unsuitable waste for fermentation from the solubilized liquid; and a second liquid-solid separator having a hydrocyclone that receives the solubilized liquid passed through the screen and centrifugalizes the solubilized liquid to separate a second unsuitable waste for fermentation from the
20 solubilized liquid, and a drainage device that receives and dehydrates the second unsuitable waste for fermentation separated by the hydrocyclone.

[0011]

In the methane fermentation pretreatment apparatus described in the above (1) first aspect of the present invention, the unsuitable waste for fermentation can be
25 removed from the solubilized liquid by the second solid-liquid separator having the

hydrocyclone and the drainage device after the unsuitable waste for fermentation is removed from the solubilized liquid by the screen that is the first solid-liquid separator. It is thereby possible to remove small-sized unsuitable waste for fermentation, such as sand, shells, eggshells, and bone fragments, which is made fine after the solubilization treatment and passed through the screen, from the solubilized liquid, using the second solid-liquid separator.

[0012]

(2) The methane fermentation pretreatment apparatus described in the above (1), further including a re-solubilization tank that receives the solubilized liquid separated by the hydrocyclone and performs a solubilization treatment on the solubilized liquid, wherein part of the solubilized liquid is returned from the re-solubilization tank to the solubilization tank.

[0013]

In the methane fermentation pretreatment apparatus described in the above (2), the solubilized liquid separated by the hydrocyclone of the second solid-liquid separator is fed to the re-solubilization tank, and part of the solubilized liquid is returned and circulated from the re-solubilization tank to the solubilization tank. By virtue of this circulation, the removal of the unsuitable waste for fermentation contained in the solubilized liquid can be repeatedly performed, and it is possible to increase the efficiency with which the unsuitable waste for fermentation is removed. Additionally, further solubilization of the solubilized liquid (fermentation feedstock) can be promoted by the re-solubilization tank, and as the pump or the like returns and circulates the solubilized liquid from the re-solubilization tank to the solubilization tank, it is also possible to promote solubilization.

[0014]

Additionally, the solubilized liquid after being treated by the second solid-liquid separator is returned from the re-solubilization tank to the solubilization tank.

Therefore, the apparent concentration of the unsuitable waste for fermentation of the solubilized liquids, which are fed from the solubilization tank to the screen that is the

5 first solid-liquid separator and further to the hydrocyclone of the second solid-liquid separator, can be reduced. Additionally, the flowability of the solubilized liquid can be improved and the removal of the unsuitable waste for fermentation can be facilitated. Moreover, by returning the solubilized liquid being treated by the second solid-liquid separator from the re-solubilization tank to the solubilization tank, the capacity of the
10 solubilization tank can be minimized, and it is possible to reduce the risk of problems caused by the floating or precipitation of scum in the solubilization tank.

[0015]

(3) the methane fermentation pretreatment apparatus described in the above (1) or (2), further including a dehydrator that receives and dehydrates the first unsuitable
15 waste for fermentation removed by the screen that is the first solid-liquid separator, and a third unsuitable waste for fermentation removed by the second solid-liquid separator.

[0016]

In the methane fermentation pretreatment apparatus described in the above (3), as the sedimentary unsuitable waste for fermentation removed by the second solid-liquid
20 separator and the floating and sedimentary unsuitable waste for fermentation removed by the screen that is the first solid-liquid separator are dehydrated by the dehydrator, the solubilized liquid (fermentation feedstock) contained in the unsuitable waste for fermentation can be separated, and can be returned to the solubilization tank. It is thereby possible to suppress reduction in the solubilized liquid while removing the
25 unsuitable waste for fermentation from the solubilized liquid with high efficiency.

Additionally, moisture can be removed from the unsuitable waste for fermentation to reduce the volume of the unsuitable waste for fermentation, and disposal of the unsuitable waste for fermentation becomes easier.

[0017]

5 (4) The methane fermentation pretreatment apparatus described in any one of the above (1) to (3), further including a crushing pump provided between the solubilization tank and the screen, wherein the driving of the crushing pump causes the solubilized liquid to be fed to the screen while being crushed from the solubilization tank, and causes part of the solubilized liquid to be returned from the crushing pump to the solubilization
10 tank or from the screen to the solubilization tank.

[0018]

In the methane fermentation pretreatment apparatus described in the above (4), as the crushing pump feeds the solubilized liquid from the solubilization tank to the screen while crushing the solubilized liquid, it is possible to promote the solubilization of
15 the solubilized liquid and to increase the efficiency with which the unsuitable waste for fermentation contained in the solubilized liquid is removed. Additionally, by returning part of the solubilized liquid from the crushing pump to the solubilization tank or from the screen to the solubilization tank, it is possible to reliably promote the solubilization of the solubilized liquid and to reliably increase the efficiency with which the unsuitable
20 waste for fermentation contained in the solubilized liquid is removed.

[0019]

(5) The methane fermentation pretreatment apparatus described in any one of the above (1) to (3), wherein the solubilization tank includes a solubilization section that receives and solubilizes the organic waste, and an adjustment section that makes a
25 solubilized liquid obtained by performing a solubilization treatment on the organic waste

in the solubilization section overflow from the solubilization section, and receives the solubilized liquid, and wherein a crushing pump is provided to suction the solubilized liquid within the solubilization section by the driving thereof and returns the solubilized liquid to the solubilization section while crushing the solubilized liquid by the driving thereof.

[0020]

In the methane fermentation pretreatment apparatus described in the above (5), the sedimentary unsuitable waste for fermentation (part of the unsuitable waste for fermentation) is retained in the solubilization section by solubilizing the organic waste by the solubilization section of the solubilization tank and making the solubilized liquid overflow from the solubilization section to the adjustment section. The solubilized liquid from which the sedimentary unsuitable waste for fermentation is removed can be temporarily stored in the adjustment section, and the solubilized liquid from which the sedimentary unsuitable waste for fermentation is removed can be fed from the adjustment section to the screen. By adopting this configuration in which the solubilized liquid is made to overflow from the solubilization section to the adjustment section, it is possible to keep constant the retention time that contributes to the solubilization to stably perform a solubilization treatment. Additionally, it is possible to increase the efficiency with which the unsuitable waste for fermentation is removed.

[0021]

Moreover, the driving of the crushing pump causes the solubilized liquid within the solubilization section to be suctioned, and be returned and circulated to the solubilization section while being crushed. It is thereby possible to promote the solubilization of the solubilized liquid, and it is possible to reliably keep constant the retention time that contributes to the solubilization to stably perform a solubilization

treatment.

[0022]

(6) The methane fermentation pretreatment apparatus described in any one of the above (1) to (5), wherein the drainage device includes a gravity separator that receives
 5 the second unsuitable waste for fermentation separated by the hydrocyclone as a sedimentary unsuitable waste concentrated liquid, and further gravitationally precipitates the second unsuitable waste for fermentation to concentrate the unsuitable waste again, a concentrated liquid fixed-amount discharger that discharges the sedimentary unsuitable waste concentrated liquid in a fixed amount from the hydrocyclone to the gravity
 10 separator discharger, and an unsuitable waste discharger that receives the second unsuitable waste for fermentation concentrated again by the gravity separator within a pipe, and conveys and discharges the unsuitable waste using a blade that moves inside the pipe.

[0023]

15 In the methane fermentation pretreatment apparatus described in the above (6), the sedimentary unsuitable waste concentrated liquid can be supplied (discharged) in a fixed amount from the hydrocyclone to the gravity separator by the concentrated liquid fixed-amount discharger. Additionally, the gravity separator enables the unsuitable waste for fermentation in the sedimentary unsuitable waste concentrated liquid to be
 20 concentrated and enables the sedimentary unsuitable waste concentrated liquid to be separated into a liquid component and an unsuitable waste for fermentation. Additionally, the unsuitable waste discharger enables the unsuitable waste for fermentation after dehydration to be conveyed and discharged out of the system. Also, for example, if a configuration is adopted in which the liquid component of the
 25 sedimentary unsuitable waste concentrated liquid, which is made to overflow or the like

from the gravity separator and is separated and discharged, is returned to the solubilization tank, it is possible to suppress reduction in the solubilized liquid while further removing the unsuitable waste for fermentation with high efficiency.

Additionally, by performing treatment using the drainage device configured in this way,

5 the volume of the unsuitable waste for fermentation can be reliably reduced, and disposal of the unsuitable waste for fermentation becomes easier.

[0024]

(7) The methane fermentation pretreatment apparatus described in the above (6), wherein a brush for scooping up and conveying the second unsuitable waste for

10 fermentation within the pipe is attached to the blade of the unsuitable waste discharger.

[0025]

In the methane fermentation pretreatment apparatus described in the above (7), in a case where it is hard to scoop up and convey the unsuitable waste for fermentation within the pipe only with the blade, as the brush is attached to the blade, the unsuitable

15 waste for fermentation can be scooped up and reliably conveyed, and it is possible to suitably discharge the unsuitable waste for fermentation.

Advantageous Effects of Invention

[0026]

20 In the methane fermentation pretreatment apparatus of the present invention, it is possible to remove small-sized unsuitable waste for fermentation, such as sand, shells, eggshells, and bone fragments, which is made fine after the solubilization treatment and passed through the screen, from the solubilized liquid, using the second solid-liquid separator.

25 [0027]

Thereby, the solubilized liquid (fermentation feedstock) in a suitable state where the unsuitable waste for fermentation is removed can be supplied to the methane fermentation tank. Additionally, in the methane fermentation tank and the subsequent steps, mechanical problems, such as deposition of the unsuitable waste for fermentation, and clogging and wear caused by the unsuitable waste for fermentation, can be prevented from occurring within the tank or in devices, such as piping, an agitator, and a pump. Additionally, since there is no case where the unsuitable waste for fermentation is accumulated in the system in large amounts without being discharged out of the system, as compared to the related art, it is possible to improve the methane fermentation function and to improve the production yield of methane gas. Moreover, it is also possible to reduce the frequency of shutdown operation in order to perform periodic cleaning of the solubilization tank, exclusion of the unsuitable waste for fermentation from the methane fermentation tank, or the like.

BRIEF DESCRIPTION OF DRAWINGS

[0028]

FIG. 1 is a block diagram showing a methane fermentation pretreatment apparatus related to a first embodiment of the present invention.

FIG. 2A is a view showing second solid-liquid separator of the methane fermentation pretreatment apparatus related to the first embodiment of the present invention.

FIG. 2B is a view showing an example of a pipe conveyor (drainage device) of the second solid-liquid separator of the methane fermentation pretreatment apparatus related to the first embodiment of the present invention.

FIG. 3 is a view showing a modified example of the pipe conveyor (drainage

device) of the second solid-liquid separator of the methane fermentation pretreatment apparatus related to the first embodiment of the present invention.

FIG. 4 is a side cross-sectional view showing the modified example of the pipe conveyor (drainage device) of the second solid-liquid separator of the methane fermentation pretreatment apparatus related to the first embodiment of the present invention.

FIG. 5 is a front view showing a brush attached to a blade of the pipe conveyor (drainage device).

FIG. 6 is a view showing a modified example of the pipe conveyor (drainage device) of the second solid-liquid separator of the methane fermentation pretreatment apparatus related to the first embodiment of the present invention.

FIG. 7 is a block diagram showing a modified example of the methane fermentation pretreatment apparatus related to the first embodiment of the present invention.

FIG. 8 is a block diagram showing a modified example of the methane fermentation pretreatment apparatus related to the first embodiment of the present invention.

FIG. 9 is a block diagram showing a methane fermentation pretreatment apparatus related to a second embodiment of the present invention.

FIG. 10 is a block diagram showing a modified example of the methane fermentation pretreatment apparatus related to the second embodiment of the present invention.

FIG. 11 is a block diagram showing a modified example of the methane fermentation pretreatment apparatus related to the second embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0029]

A methane fermentation pretreatment apparatus related to a first embodiment of
5 the present invention will be described below referring to FIGS. 1 to 6. Here, the
present embodiment relates to a methane fermentation pretreatment apparatus used for
pretreatment before a methane fermentation treatment is performed on organic waste
(biomass feedstock), such as garbage and fish processing waste.

[0030]

10 A methane fermentation pretreatment apparatus A of the present embodiment, as
shown in FIG. 1, includes an input hopper 1 that receives organic waste (hereinafter
referred to as waste) S1, a crusher 2 (2a, 2b), a sorter 3, a solubilization tank 4, first
solid-liquid separator 5, a dehydrator 6, and second solid-liquid separator 7.

[0031]

15 The crusher 2 crushes the waste S1 supplied from the input hopper 1. In the
present embodiment, the crusher 2 is configured so as to perform two-step crushing by a
coarse crusher 2a and a fine crusher 2b. For example, the particle diameter after
crushing is set to 200 mm or less in the coarse crusher 2a, and the particle diameter after
crushing is set to 50 mm or less in the fine crusher 2b that is more finely crushed after the
20 coarse crusher 2a.

[0032]

Since the type of the waste S1 is various, the crusher 2 is not necessarily limited
to the present embodiment, but the number, type, combination, or the like of the crusher
may be appropriately selected according to the form of the waste S1 to be introduced.
25 For example, in a case where a large amount of large-sized solid garbage is included, it is

preferable to use biaxial crushing device or hammer crushing device as a coarse crusher 2a and use biaxial crushing device as a fine crusher 2b. Additionally, in the case of garbage with small amount of fibers or the like, for example, it is preferable to use compression crushing device. Additionally, in the case of garbage with small amount of moisture, for example, it is preferable to use pulping device.

[0033]

The sorter 3 is, for example, a sorter of a rotary drum type or a sifter type, and coarsely sorts large-sized unsuitable waste for fermentation (coarse unsuitable waste), such as vinyl that is mixed in waste S2 crushed by the crusher 2.

10 [0034]

The solubilization tank 4 solubilizes waste S3 (slurry preparation) after part of the unsuitable waste for fermentation is removed by being coarsely sorted by the sorter 3, so as to have a predetermined moisture amount of, for example, 85% or more. Water, an acidic aqueous solution, or an alkaline water solution can be used as a liquid that is mixed with the waste S3 in the solubilization tank 4. Additionally, the solubilization tank 4 agitates the waste S3 fed from the sorter 3 while heating the waste by a heating device 8, to thereby perform solubilization to generate a solubilized liquid (fermentation feedstock) S4. Additionally, the heating device 8, for example, blows steam into the waste S3 to heat the waste, or heats the circulated waste S3 by exchanging heat. Also, in the present embodiment, the waste S3 is heated to about 40°C and solubilized by the heating device 8 so as to generate a solubilized liquid S4.

[0035]

The first solid-liquid separator 5 is provided to remove unsuitable waste for fermentation (a first unsuitable waste for fermentation), such as large-sized vinyl, which remains and is contained in the solubilized liquid S4, from the solubilized liquid S4.

Also, in the present embodiment, the first solid-liquid separator 5 is, for example, a screen with a mesh aperture of about 1 to 20 mm, preferably, about 10 to 12 mm. The solubilized liquid S4 is fed from the solubilization tank 4 by driving a pump 9, and the solubilized liquid passes through the screen, thereby the screen traps and removes part of
5 the unsuitable waste for fermentation in the solubilized liquid S4.

[0036]

As the screen 5, for example, a drum screen, a sheave, or the like can be used. Additionally, as a net portion of the screen 5 that causes the solubilized liquid S4 to pass therethrough, for example, a weaved metal net (a metal net obtained by weaving a metal
10 line), a punched metal (a screen processed by punching holes in a material made mainly of metal), a wedge wire (a screen that has an inverted triangular cross-section and has meshes (slits) formed by arranging deformed wires at equal intervals), or the like is used.

[0037]

The dehydrator 6 receives the unsuitable waste for fermentation trapped and
15 removed by the screen 5, and is provided so as to dehydrate this unsuitable waste. Additionally, in the present embodiment, the solubilized liquid S5 obtained by being dehydrated by the dehydrator 6 is returned to the solubilization tank 4.

[0038]

The second solid-liquid separator 7 is provided to remove small-sized unsuitable
20 waste for fermentation, such as sand, shells, eggshells, and bone fragments, which is made fine after the treatment of the solubilization tank 4 and passes through the screen that is the first solid-liquid separator 5, from the solubilized liquid. Also, in the present embodiment, the second solid-liquid separator 7, as shown in FIGS. 1 and 2A, includes a hydrocyclone 10 and a drainage device 27. Additionally, the drainage device 27
25 includes a rotary valve (concentrated liquid fixed-amount discharger) 12, a drainage tank

(gravity separator) 13, and a pipe conveyor (unsuitable waste discharger) 11.

[0039]

The hydrocyclone 10 separates an unsuitable waste for fermentation (a second unsuitable waste for fermentation) contained in the solubilized liquid S7 from a solubilized liquid S7 by passing through the screen 5, receiving the solubilized liquid S6 with the driving of the pump 36, and causing a centrifugal force to act on the solubilized liquid.

[0040]

Also, the second solid-liquid separator 7 is configured so that sedimentary unsuitable waste concentrated liquid containing sedimentary unsuitable waste for fermentation that is separated by the hydrocyclone 10 is discharged to the pipe conveyor 11 through the rotary valve 12 and the drainage tank 13 of the drainage device 27 installed below the hydrocyclone 10. That is, in the drainage device 27, the hydrocyclone 10 and the rotary valve 12 are connected together in a sealed state, the interior of the drainage tank 13 below the rotary valve 12 is temporarily released to the atmosphere, and the sedimentary unsuitable waste concentrated liquid discharged from a lower part of the hydrocyclone 10 is supplied to the drainage tank 13. Additionally, the drainage tank 13 and the pipe conveyor 11 are connected together in a sealed state again, the sedimentary unsuitable waste concentrated liquid received by the drainage tank 13 is further precipitated and concentrated by gravitational separation, and is received by the pipe conveyor 11. Additionally, the drainage tank 13 is provided with a drainage port 21 that drains a liquid by overflow.

[0041]

Additionally, the pipe conveyor 11, as shown in FIGS. 2A and 2B, includes a cylindrical pipe 15, a plurality of blades 16, a towing body 17, a drive unit 18, and a

discharge port 20. The pipe 15 is arranged with differences in height, and the discharge port 20 is arranged at least at a position higher than an overflow position of the drainage port 21 of the drainage tank 13. Also, the plurality of blades 16 is formed by having a through hole each, is coupled together by the towing body 17, and is arranged inside the pipe 15. Additionally, the plurality of blades 16 is towed by the towing body 17 with the driving of the drive unit 18, and is provided so as to move inside the pipe 15.

[0042]

Next, a pretreatment method of the organic waste (biomass feedstock) S1 using the methane fermentation pretreatment apparatus A of the present embodiment having the above configuration will be described. Additionally, the operation and effects of the methane fermentation pretreatment apparatus A of the present embodiment will be described.

[0043]

First, the waste S1, such as garbage, is input into the input hopper 1, and the waste S1 is sequentially crushed by the coarse crusher 2a and the fine crusher 2b. Then, the waste S2 crushed to a predetermined particle diameter or less is fed to the sorter 3, large-sized unsuitable waste for fermentation, such as vinyl mixed in the waste S2 is coarsely sorted by the sorter 3, and the waste S3 from which the coarse unsuitable waste is removed is fed to the solubilization tank 4.

[0044]

Next, in the solubilization tank 4, the waste S3 is agitated while being heated by the heating device 8, and is thereby solubilized to generate the solubilized liquid S4. Additionally, the solubilized liquid S4 is fed from the solubilization tank 4 to the screen 5 by driving the pump 9, and the solubilized liquid S4 passes through the screen 5, thereby the unsuitable waste for fermentation (the first unsuitable waste for fermentation), such

as large-sized vinyl contained in the solubilized liquid S4 is trapped and removed from the solubilized liquid S4. At this time, the unsuitable waste for fermentation trapped by the screen 5 is dehydrated by the dehydrator 6, and the solubilized liquid S5 obtained by this dehydration is returned to the solubilization tank 4. Thereby, the solubilized liquid S5 that is the fermentation feedstock is returned to the interior of the system, and it is possible to suppress reduction in the solubilized liquid S7. Incidentally, the solubilized liquid has a viscosity of several thousands cp at low concentration and has a viscosity of several tens of thousands cp at high concentration.

[0045]

On the other hand, small-sized unsuitable waste for fermentation, such as sand, shells, eggshells, and bone fragments, in which a considerable portion is made fine after the treatment of the solubilization tank 4, remains in the solubilized liquid S6 passed through the screen 5 without being trapped by the screen 5.

[0046]

In contrast, in the present embodiment, the solubilized liquid S6 in which such an unsuitable waste for fermentation remains and is contained is fed to the hydrocyclone 10 of the second solid-liquid separator 7 by the driving of the pump 36. Then, the small-sized unsuitable waste for fermentation contained in the solubilized liquid S7 is separated from the solubilized liquid S7. The separated unsuitable waste for fermentation (the second unsuitable waste for fermentation) passes through the rotary valve 12, and is discharged to the drainage tank 13 as the sedimentary unsuitable waste concentrated liquid. The sedimentary unsuitable waste concentrated liquid that is once opened to the atmosphere in the drainage tank 13 is further gravitationally precipitated and again concentrated within the drainage tank 13, a liquid that does not contain the unsuitable waste for fermentation is drained from the drainage port 21, and the unsuitable

waste for fermentation that is again concentrated is discharged to the pipe conveyor 11 from the lower part of the drainage tank 13. In the pipe conveyor 11, if the driving of the drive unit 18 causes the towing body 17 to be towed and causes the blades 16 to move inside the pipe 15, the unsuitable waste for fermentation (a third unsuitable waste for fermentation) contained in the sedimentary unsuitable waste concentrated liquid is transported and discharged to the discharge port 20. Additionally, a liquid component (solubilized liquid S8) of the sedimentary unsuitable waste concentrated liquid discharged from the drainage port 21 of the drainage tank 13 is returned to the solubilization tank 4 in the present embodiment. Thereby, the solubilized liquid S8 that is the fermentation feedstock is returned to the interior of the system, and it is possible to suppress reduction in the solubilized liquid S7.

[0047]

Here, as shown in FIGS. 3 to 6, a single or a plurality of brushes 19 may be attached to the surface of the blade 16 so that the unsuitable waste for fermentation within the pipe 15 of the pipe conveyor 11 can be efficiently and reliably scooped up and conveyed by the brush 19. For example, the brush 19 preferably includes a cylindrical attaching portion 22, and a trapping portion 23 that is integrally attached to a side surface of the attaching portion 22 and is made of a wire brush. Additionally, it is preferable that the trapping portion 23 be inscribed on the inner surface of the pipe 15 and an opening 24 be provided and formed at a position where the towing body 17 is arranged. The brush 19 configured in this way is attached to the blade 16 by inserting a bolt 25 through a through hole provided in the blade 16 and an inner hole of the attaching portion 22, and fixing the bolt with a nut 26. At this time, the towing body 17 is arranged in the portion of the opening 24 of the trapping portion 23 so that the towing body 17 and the trapping portion 23 do not interfere with each other. In addition, as shown in FIG. 6, a

fan-like trapping portion 23 may be provided on a side surface of the attaching portion 22 so as to constitute the pipe conveyor 11.

[0048]

On the other hand, the solubilized liquid S7 after being treated by the
5 hydrocyclone 10 is fed to a methane fermentation tank (methane fermentation step), and methane fermentation (production of methane gas (biofuel)) is performed using the solubilized liquid S7 as the fermentation feedstock.

[0049]

For this reason, the solubilized liquid S7 in a suitable state where the unsuitable
10 waste for fermentation is removed is supplied to the methane fermentation tank, and in the methane fermentation tank and the subsequent steps mechanical problems, such as deposition of the unsuitable waste, and clogging and wear caused by the unsuitable waste, do not occur within the tank or in devices, such as piping, an agitator, and a pump.

[0050]

15 Accordingly, in the methane fermentation pretreatment apparatus A of the present embodiment, the unsuitable waste for fermentation can be removed from the solubilized liquid S6 by the second solid-liquid separator 7 having the hydrocyclone 10 and the drainage devices 11 and 13 after the unsuitable waste for fermentation is removed from the solubilized liquid S4 by the screen that is the first solid-liquid separator 5. It is
20 thereby possible to remove small-sized unsuitable waste for fermentation, such as sand, shells, eggshells, and bone fragments, which is made fine after the treatment of the solubilization tank 4 and passes through the screen 5, from the solubilized liquid S6, using the second solid-liquid separator 7.

[0051]

25 Hence, according to the methane fermentation pretreatment apparatus A of the

present embodiment, the solubilized liquid S7 (fermentation feedstock) in a suitable state where the unsuitable waste for fermentation is removed can be supplied to the methane fermentation tank. Additionally, in the methane fermentation tank and the subsequent steps mechanical problems, such as deposition, clogging, and wear, can be prevented from occurring within the tank or in devices, such as piping, an agitator, and a pump. Additionally, since there is no case where the unsuitable waste for fermentation is accumulated in the system in large amounts without being discharged out of the system, as compared to the related art, it is possible to improve the methane fermentation function and to improve the yield at which methane gas is manufactured. Moreover, it is also possible to reduce the frequency of shutdown operation in order to perform periodic cleaning of the solubilization tank 4, exclusion of the unsuitable waste for fermentation of the methane fermentation tank, or the like.

[0052]

Additionally, in the methane fermentation pretreatment apparatus A of the present embodiment, the drainage device 27 includes the drainage tank (gravity separator) 13, the rotary valve (concentrated liquid fixed-amount discharger) 12, and the pipe conveyor (unsuitable waste discharger) 11. Thereby, a fixed amount of sedimentary unsuitable waste concentrated liquid can be supplied (discharged) from the hydrocyclone 10 to the drainage tank 13 by the rotary valve 12. Additionally, the drainage tank 13 enables the unsuitable waste for fermentation in the sedimentary unsuitable waste concentrated liquid to be concentrated and enables the sedimentary unsuitable waste concentrated liquid to be separated into a liquid component and an unsuitable waste for fermentation. Additionally, the pipe conveyor 11 enables the unsuitable waste for fermentation after dehydration to be conveyed and discharged out of the system. Also, by returning the liquid component of the sedimentary unsuitable

waste concentrated liquid, which is made to overflow from the drainage tank 13 and is separated and discharged, to the solubilization tank 4, it is possible to suppress reduction in the solubilized liquid while further removing the unsuitable waste for fermentation with high efficiency. Additionally, by performing treatment using the drainage device
5 27 configured in this way, the volume of the unsuitable waste for fermentation can be reliably reduced, and disposal of the unsuitable waste for fermentation becomes easier.

[0053]

Moreover, by attaching the brush 19 for conveying the unsuitable waste for fermentation within the pipe 15 while scooping up the unsuitable waste, to the blade 16
10 of the pipe conveyor 11, in a case where it is hard to scoop up and convey the unsuitable waste for fermentation within the pipe 15 only with the blade 16, the unsuitable waste for fermentation can be scooped up and reliably conveyed, and it is possible to suitably discharge the unsuitable waste for fermentation.

[0054]

15 Although the first embodiment of the methane fermentation pretreatment apparatus related to the present invention has been described above, the present invention is not limited to the above first embodiment, and can be appropriately changed without departing from the scope thereof.

[0055]

20 For example, in the present embodiment, the methane fermentation pretreatment apparatus A includes the input hopper 1, the crusher 2, the sorter 3, the solubilization tank 4, the first solid-liquid separator 5, the dehydrator 6, and the second solid-liquid separator 7. However, the methane fermentation pretreatment apparatus related to the present invention needs only to include at least the solubilization tank 4, the first solid-liquid
25 separator 5, and the second solid-liquid separator 7. If the apparatus includes these

constituent elements 4, 5, and 7, it is possible to obtain the working effects of the present embodiment.

[0056]

Additionally, as shown in FIG. 7, a re-solubilization tank 30 that receives the
5 solubilized liquid S7 separated by the hydrocyclone 10 of the second solid-liquid
separator 7 may be provided so that part of the solubilized liquid S9 is returned from the
re-solubilization tank 30 to the solubilization tank 4 by the pump 31. In this case, in
addition to the working effects of the present embodiment, part of the solubilized liquid
S9 is returned and circulated from the re-solubilization tank 30 to the solubilization tank
10 4. This enables the removal of the unsuitable waste for fermentation to be repeatedly
performed by circulation. Hence, it is possible to increase the efficiency with which the
unsuitable waste for fermentation is removed.

[0057]

Additionally, further solubilization can be promoted by feeding the solubilized
15 liquid S7 separated by the hydrocyclone 10 to the re-solubilization tank 30 and heating
the solubilized liquid S7 within the re-solubilization tank 30 using the heating device 32.
In this way, further solubilization of the solubilized liquid S7 can be promoted by the
re-solubilization tank 30. Additionally, as the pump 31 or the like returns and circulates
the solubilized liquid S9 from the re-solubilization tank 30 to the solubilization tank 4, it
20 is also possible to promote solubilization.

[0058]

Additionally, the solubilized liquid S7 subjected to the removal treatment of the
unsuitable waste for fermentation is returned from the re-solubilization tank 30 to the
solubilization tank 4 by the second solid-liquid separator 7. For this reason, the
25 apparent concentration of the unsuitable waste for fermentation of the solubilized liquids

S4 and S6, which are fed from the solubilization tank 4 to the screen 5 and to the hydrocyclone 10 of the second solid-liquid separator 7, can be reduced. Additionally, the flowability of the solubilized liquids S4 and S6 can be improved. This can facilitate the removal of the unsuitable waste for fermentation. Moreover, as the second solid-liquid separator 7 returns the solubilized liquid S7 subjected to the removal treatment of the unsuitable waste for fermentation from the re-solubilization tank 30 to the solubilization tank 4, the capacity of the solubilization tank 4 can be minimized, and it is also possible to reduce the risk of a trouble caused by the floating or precipitation of scum in the solubilization tank 4.

10 [0059]

Additionally, as shown in FIG. 8, the dehydrator 6 may receive the unsuitable waste for fermentation removed by the screen that is the first solid-liquid separator 5 and the unsuitable waste for fermentation removed by the second solid-liquid separator 7 so that dehydration is performed in the dehydrator 6. In this case, the sedimentary unsuitable waste for fermentation removed by the second solid-liquid separator 7 and the floating and sedimentary unsuitable waste for fermentation removed by the screen that is the first solid-liquid separator 5 are dehydrated by the dehydrator 6. This enables the solubilized liquid (fermentation feedstock) S5 contained in the unsuitable waste for fermentation to return to the solubilization tank 4. Hence, it is possible to suppress reduction in the solubilized liquid S7 while removing the unsuitable waste for fermentation with high efficiency. Additionally, the volume of the unsuitable waste for fermentation can be reduced, and disposal of the unsuitable waste for fermentation becomes easier.

[0060]

25 Next, a methane fermentation pretreatment apparatus related to a second

embodiment of the present invention will be described referring to FIG. 9. Here, the present embodiment, similarly to the first embodiment, relates to a methane fermentation pretreatment apparatus used for pretreatment before a methane fermentation treatment is performed on organic waste (biomass feedstock), such as garbage and fish processing waste. For this reason, the same components as those of the first embodiment are designated by the same reference numerals, and the detailed description thereof is omitted.

[0061]

As shown in FIG. 9, a methane fermentation pretreatment apparatus B of the present embodiment, similarly to the first embodiment, includes the input hopper 1 that receives organic waste (hereinafter referred to as waste) S1, the crusher 2, the sorter 3, the solubilization tank 4, the first solid-liquid separator 5, the dehydrator 6, and the second solid-liquid separator 7.

[0062]

On the other hand, the methane fermentation pretreatment apparatus A of the present embodiment includes a crushing pump 33 provided between the solubilization tank 4 and the screen that is the first solid-liquid separator 5, and is configured to crush the solubilized liquid S4 from the solubilization tank 4 by the driving of the crushing pump 33 to feed the crushed solubilized liquid to the screen 5, while returning part of the solubilized liquid S6 from the screen 5 to the solubilization tank 4. In addition, the crushing pump 33 is a pump including a crushing mechanism, for example, a centrifugal pump including a cutting blade and a stationary cutting blade before an impeller. Then, the solubilized liquid S4 is pumped by the driving of the crushing pump 33, and the unsuitable waste for fermentation in solubilized liquid S4 is crushed (cut).

[0063]

In the methane fermentation pretreatment apparatus B of the present embodiment configured in this way, in addition to the working effects of the first embodiment, the solubilization of the solubilized liquid (fermentation feedstock) S4 can be promoted by feeding the solubilized liquid S4 from the solubilization tank 4 to the screen 5 while crushing the solubilized liquid, using the crushing pump 33.

[0064]

Additionally, the solubilized liquid S4 fed to the screen 5 by the driving of the crushing pump 33, similarly to the first embodiment, is fed to the hydrocyclone 10 of the second solid-liquid separator 7. Additionally, part of the solubilized liquid is returned from the screen 5 to the solubilization tank 4 by a pumping pressure applied by the crushing pump 33. Thereby, the solubilized liquids S4 and S6 are circulated from the solubilization tank 4 to the crushing pump 33, from the crushing pump 33 to the screen 5, and from the screen 5 to the solubilization tank 4.

[0065]

As the solubilized liquid S4 or S6 are circulated in this way, the solubilization of the solubilized liquid S4 or S6 can be reliably promoted by the solubilization tank 4 or the crushing pump 33. Additionally, as the solubilized liquid S4 or S6 is circulated, it is possible to increase the efficiency with which the unsuitable waste for fermentation contained in the solubilized liquid S4 or S6 is removed by the solubilization tank 4 or the screen 5.

[0066]

Although the second embodiment of the methane fermentation pretreatment apparatus related to the present invention has been described above, the present invention is not limited to the above second embodiment, includes modified examples of the first examples, and can be appropriately changed without departing from the scope thereof.

[0067]

For example, as shown in FIG. 10, a configuration may be adopted in which the crushing pump 33 is provided between the solubilization tank 4 and the screen 5, and the driving of the crushing pump 33 causes the solubilized liquid S4 to be crushed from the solubilization tank 4 and fed to the screen 5, and causes part of the solubilized liquid S4 to be returned from the crushing pump 33 to the solubilization tank 4. Even in this case, similarly to the present embodiment, as the crushing pump 33 feeds the solubilized liquid S4 from the solubilization tank 4 to the screen 5 while crushing the solubilized liquid, it is possible to promote the solubilization of the solubilized liquid S4 and to increase the efficiency with which the unsuitable waste for fermentation contained in the solubilized liquid S4 is removed. Additionally, by returning part of the solubilized liquid S4 from the crushing pump 33 to the solubilization tank 4, it is possible to reliably promote the solubilization of the solubilized liquid S4 and to reliably increase the efficiency with which the unsuitable waste for fermentation contained in the solubilized liquid S4 is removed.

[0068]

Moreover, as shown in FIG. 11, the solubilization tank 4 may include a solubilization section 34 that receives and solubilizes the waste S3 after being sorted by the sorter 3, and an adjustment section 35 that receives the solubilized liquid S9 made to overflow from the solubilization section 34. Additionally, in addition to this, the crushing pump 33 that suctions the solubilized liquid S9 within the solubilization section 34 by the driving thereof and returns the solubilized liquid to the solubilization section 34 while crushing the solubilized liquid by the driving thereof may be provided.

[0069]

In this case, the waste S3 is solubilized by the solubilization section 34 of the

solubilization tank 4, and the solubilized liquid S9 is made to overflow from the solubilization section 34 to the adjustment section 35. Thereby, the sedimentary unsuitable waste for fermentation (part of the unsuitable waste for fermentation) can be retained in the solubilization section 34, and the solubilized liquid S9 from which the sedimentary unsuitable waste for fermentation is removed can be temporarily stored in the adjustment section 35, and can be fed from the adjustment section 35 to the screen 5. By adopting this configuration in which the solubilized liquid S9 is made to overflow from the solubilization section 34 to the adjustment section 35, it is possible to keep constant the retention time that contributes to the solubilization to stably perform a solubilization treatment, and it is possible to increase the efficiency with which the unsuitable waste for fermentation is removed.

[0070]

Additionally, as the crushing pump 33 suctions the solubilized liquid S9 within the solubilization section 34, crushes the solubilized liquid, and returns and circulates the solubilized liquid to the solubilization section 34, solubilization can be promoted. Additionally, it is possible to reliably keep constant the retention time that contributes to the solubilization to stably perform a solubilization treatment.

INDUSTRIAL APPLICABILITY

[0071]

In the methane fermentation pretreatment, the recovery amount of the solubilized liquid as the fermentation feedstock increases. Additionally, the maintenance of the methane fermentation pretreatment apparatus becomes easier. As a result, the efficiency of methane fermentation treatment of organic waste is improved.

Reference Signs List

[0072]

- 1: INPUT HOPPER
- 2: CRUSHER
- 5 2a: COARSE CRUSHER
- 2b: FINE CRUSHER
- 3: SORTER
- 4: SOLUBILIZATION TANK
- 5: FIRST SOLID-LIQUID SEPARATOR (SCREEN)
- 10 6: DEHYDRATOR
- 7: SECOND SOLID-LIQUID SEPARATOR
- 8: HEATING DEVICE
- 9: PUMP
- 10: HYDROCYCLONE
- 15 11: PIPE CONVEYOR (UNSUITABLE WASTE DISCHARGER)
- 12: ROTARY VALVE (CONCENTRATED LIQUID FIXED-AMOUNT DISCHARGER)
- 13: DRAINAGE TANK (GRAVITY SEPARATOR)
- 15: PIPE
- 20 16: BLADE
- 17: TOWING BODY
- 18: DRIVE UNIT
- 19: BRUSH
- 20: DISCHARGE PORT
- 25 21: DRAINAGE PORT

- 22: ATTACHING PORTION
- 23: TRAPPING PORTION
- 24: OPENING
- 25: BOLT
- 5 26: NUT
- 27: DRAINAGE DEVICE
- 30: RE-SOLUBILIZATION TANK
- 31: PUMP
- 32: HEATING DEVICE
- 10 33: CRUSHING PUMP
- 34: SOLUBILIZATION SECTION
- 35: ADJUSTMENT SECTION
- 36: PUMP
- A: METHANE FERMENTATION PRETREATMENT APPARATUS
- 15 B: METHANE FERMENTATION PRETREATMENT APPARATUS

CLAIMS

1. A methane fermentation pretreatment apparatus used for pretreatment before a methane fermentation treatment is performed on organic waste, the apparatus comprising:

- a solubilization tank in which a solubilization treatment is performed on the organic waste;

- a screen that is a first solid-liquid separator through which a solubilized liquid obtained by performing a solubilization treatment in the solubilization tank on the organic waste is passed to remove a first unsuitable waste for fermentation from the solubilized liquid; and

- a second liquid-solid separator having a hydrocyclone that receives the solubilized liquid passed through the screen and centrifugalizes the solubilized liquid to separate a second unsuitable waste for fermentation from the solubilized liquid, and a drainage device that receives and dehydrates the second unsuitable waste for fermentation separated by the hydrocyclone,

- wherein the drainage device includes:

- a gravity separator that receives the second unsuitable waste for fermentation separated by the hydrocyclone as a sedimentary unsuitable waste concentrated liquid, and further gravitationally precipitates the second unsuitable waste for fermentation to concentrate the unsuitable waste again;

- a concentrated liquid fixed-amount discharger that discharges the sedimentary unsuitable waste concentrated liquid in a fixed amount from the hydrocyclone to the gravity separator discharger;

- an unsuitable waste discharger that receives the second unsuitable waste for fermentation concentrated again by the gravity separator within a pipe, and conveys and discharges the unsuitable waste using a blade that moves inside the pipe; and

- a drainage port that drains a liquid component of the sedimentary unsuitable waste concentrated liquid by overflow, and

- wherein the pipe of the unsuitable waste discharger is arranged over different heights, and a discharge port of the unsuitable waste discharger is arranged at least at a position higher than an overflow position of the drainage port of the drainage device, and

- wherein the liquid component drained from the drainage port of the drainage device is returned to the solubilization tank.

2. The methane fermentation pretreatment apparatus according to Claim 1, further

comprising:

a re-solubilization tank that receives the solubilized liquid separated by the hydrocyclone and performs a solubilization treatment on the solubilized liquid, wherein part of the solubilized liquid is returned from the re-solubilization tank to the solubilization tank.

3. The methane fermentation pretreatment apparatus according to Claim 1 or 2, further comprising:

a dehydrator that receives and dehydrates the first unsuitable waste for fermentation removed by the screen that is the first solid-liquid separator, and a third unsuitable waste for fermentation removed by the second solid-liquid separator.

4. The methane fermentation pretreatment apparatus according to any one of Claims 1 to 3, further comprising:

a crushing pump provided between the solubilization tank and the screen, wherein the driving of the crushing pump causes the solubilized liquid to be fed to the screen while being crushed from the solubilization tank, and causes part of the solubilized liquid to be returned from the crushing pump to the solubilization tank or from the screen to the solubilization tank.

5. The methane fermentation pretreatment apparatus according to any one of Claims 1 to 3, wherein the solubilization tank includes:

a solubilization section that receives and solubilizes the organic waste, and an adjustment section that makes a solubilized liquid obtained by performing a solubilization treatment on the organic waste in the solubilization section overflow from the solubilization section, and receives the solubilized liquid, and

wherein a crushing pump is provided to suction the solubilized liquid within the solubilization section by the driving of the crushing pump and returns the solubilized liquid to the solubilization section while crushing the solubilized liquid by the driving of the crushing pump.

6. The methane fermentation pretreatment apparatus according to Claim 1,

wherein a brush for scooping up and conveying the second unsuitable waste for fermentation within the pipe is attached to the blade of the unsuitable waste discharger.